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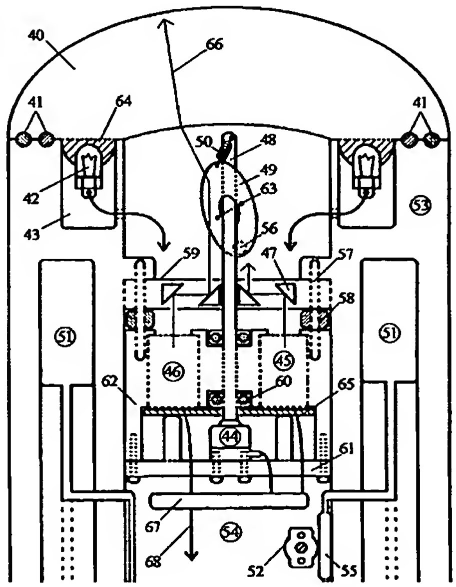
(54) Title: LASER LIGHT LURE



(57) Abstract: A laser light lure device comprises a laser light aquatic species as herein defined attractant or distractant device characterised in that the species is pre-selected for catching and/or distracting in that the wavelength of the laser light is selected to catch and/or distract the species concerned by forming *inter alia* a visible or humanly invisible (i.e. UV) continuous or discontinuous ring about the mouth of a fishing trawler net (not shown). Motor (44), angled ellipsoidal mirror (49), right angled mirrors (47), mirrors housing (59), pin (63), lasers (45, 46), spring (50), weight (56), motor spindle (48), bearings (60), housing (62), impact protection (58, 65), dowels (57), back-plate (61), self-levelling devices (51), fluid reservoir (55), pump (52), control electronics (67), differential pressure switch (not shown), optically clear casing (40), casing (53), "O" rings (41), background lights (42), spaced array (43), reflector (64), rigid foam (54), power (68), exterior light ray (66).

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Laser Light Lure

The present invention relates to a laser light lure and particularly to a method of fishing incorporating a laser light lure mounted in a shaped device directly onto or below a fishing trawler or onto a trawler fishing net and/or aquaculture repositories. The invention also comprehends cephalopods, cetaceans, chordata pisces and arthropodum crustacea.

Traditionally fish hooks and nets are used for fishing purposes in for example fresh water lakes and saltwater seas. Prior art figure 1 shows a fish hook typically used for this purpose. Prior art figure 2 shows a section of netting as used in commercial trawling industries. Prior art Figure 3 shows a laser diode (3) diverging laser light beam (4) light collimator lens (5) and corrected parallel laser light beam (6) as found in a typical working laser diode model. Prior art Figure 4 shows a method of fishing with a trawler as used in commercial industry inclusive of a boat (7) attached to a trawl net by means of a net attachment ropes (8) to the net (9) to submerge below a waterline (11). Fish (10) are located by sonar echolocation methods (not shown) and boat (7) is driven to capture said fish (10) in accordance with usual practice.

One of the problems with fishing *inter alia* is that large numbers of fish are caught over quota and are returned to the sea since they can not be landed, but unfortunately they return to the sea dead. This situation has resulted in grave difficulties for the fishing quota system since stocks in some fishing grounds are now essentially depleted. Experiments with various fish lures followed the logical path of prototype devices that stimulate each of the fishes known senses, and finally resulted in a form of attraction that is common to all commercially fished species. Humanly visible laser light or coherent light that is presently available in a variety of colours had a markedly interesting effect on differing fish species with vision and improvements noted when solitary beams of narrow width were aimed at them. A strong feeding reaction along with grouping and shoaling were noted, especially with the green (532-nanometer) wavelength laser type. A green laser light aimed into a tank of fish such as whiting had instantaneous results. The only real problem at present was in the form of water turbidity. Light back-scatter as a result of excessive particulates in the water impeded the formation of a single point of light. This however relates almost wholly to coastal regions around heavily industrialised islands. Further out to sea the water is suitably clear enough to enable the process to work well. The use of modulated (pulsed on and off) laser light has been shown to improve the penetration of laser light into water by reducing backscatter. Modulation also significantly reduces the retinal contact

time between the target aquatic species and the laser beam, significantly reducing the chance of photonic-heat damage as well as reducing the laser power needed for adequate water penetration. It is known only that lasers can attract fish to a given target.

For example US-A-4815815, WO/0004769, US-A-4501084, US-A-5987802 and US-A-5758450. The South West Fisheries Science Center Administrative Report LJ-89-10C is also interesting in this respect.

The first of the above specifications further relates to a radiated light from an under water laser to scatter or group a fish species using a suitable light source. What has not been found is A) That a given aquatic e.g. fish species reacts differentially to a laser light source, thus cod and bass do not respond to a 532nM green laser whereas codling do, whiting and mullet fry, for example respond to red and green laser light. B) Further the inventors have found that a response to laser light appears to be in part at least a function of normal swim and/or feeding depths of the species concerned. Thus a red laser is more effective on a surface fish, green is more effective on a mid-depth fish and blue is more effective on deep-water species. These species are generally those to be found down to the following depths: - surface fish down to about 200 meters, middle depth fish down to about 200-800 meters, and deep fish down to about 800-3000 meters.

There is in fact an example in the Angler fish that is to be found *inter alia* in the North Sea. The mid-deep water variety of this fish captures its prey by shining a bioluminescent light with peak emission spectrum in yellow/green (@500nM). The deep-water variety has a peak emission spectrum green/blue (@470nM). It is understood that these bioluminescent lights are not laser (or coherent) light in nature and therefore are only used for local prey capture.

Fish are normally devided into groups depending on their place in the ocean, by these groups, fishermen and marine biologists know where a particular species is to be found and the conditions within which the species is likely to be living. Demersal, pelagic and benthic are typically used terms. Combinations of these group names for example bentho-pelagic, refer to fish that are found on the deep ocean floor.

The variables to be considered when choosing the laser operating characteristics are as follows: -

i. Depth of species (Normal swim and/or feed depth).

ii. Maturity of species (Adult or juvenile of single species).

iii. Colour of water local to species (Ambient light absorption spectra).

iv. Turbidity of water local to species (Percentage of suspended matter).

v. Migratory nature of species (Local or migratory seasonal).

vi. Peak rhodopsin absorption spectra (Found in retinal Rods and/or Cones)

vii. Lens of eye pigmentation (Altering the overall peak spectral sensitivity).

viii. Nature of species (Predatory or docile).

ix. Nature of species (ii) Dominant or non-dominant.

x. Environment of species (Ambient visible and/or UV light levels affecting energy levels of laser required).

xi. Environment of species (ii) Fish farmed and therefore aquarium typical or sea-caught).

xii. Environment of species (iii) Presence and type of other species in shoal for capture or distraction.

xiii. Sex of species (Differences between male and female of single species behavior patterns).

xiv. Type and size of given species food source (Determining initial beam diameter).

xv. Number of available pigments in the eye of given aquatic family (e.g. salmonidae has many).

xvi. The diameter of and lens type of the eye (Affecting light sensitivity).

xvii. Post filtering and/or frequency tuning of laser light (Ensuring different species capture if peak spectra are close).

An example of the above approach was applied to juvenile salmon (teleost fish). Particular species of which are grown in shallow water fish farms. They would be as with most juvenile fish tested empirically to date, normally red and/or green laser light attracting. Salmon grow at different rates; dominant juveniles can be larger than adults. The young of the species (smolt) do not grow the specialised, polarised ultraviolet light sensitive retinal rods used for migratory purposes in the normal adult salmon life cycle. But the dominant juveniles and adults see in the UV spectrum although at different sensitivities and/or peak spectra within it. With known peaks @ 360, 405 and 420nm, a UV or selected blue and/or green/blue light is preferentially used to separate dominant juvenile and/or adult salmon from smolt.

This example includes a Loch Linnhe Scotland, whose waters are yellow coloured owing to the high peat content. As a direct result of this, the yellow coloured water quickly absorbs a laser in the green visible spectrum and subsequently the use of strong lasers is advised. The dominant adult and adult sized, dominant juvenile lens absorption spectra is taken into consideration here and one of the given UV sensitivities targeted to allow for this allowing capture. The remaining fish can then be left to mature themselves yielding further dominants that can be removed, as necessary. Non-dominant adults and non-dominant juveniles would have different lens absorption characteristics to the adult salmon and again a specific laser frequency would then be used for them as necessary. The majority of United Kingdom salmon are farmed in UK fisheries. Dominant adult salmon including dominant juveniles would be located in the uppermost part of the farm area, where they have access to the first food sources that land on the surface during normal feeding operations. Whatever is left of this food sinks to the bottom of the contained net area, whereupon the smaller non-dominant salmon then feed (Of which some are also adults but smaller, i.e.: Juvenile sized). After some nine or so months of maturation, fish farmers have the task of separating (or grading) the salmon for harvesting purposes. The process of harvesting is often slow and excessively stresses the fish, causing poor meat quality post-cull. The above given process could greatly improve the rate of capture.

A short test of the above process was conducted near Fort William in Scotland with a variation of the device as in Figure 11. Results using a green 532nm class 3b laser were very interesting with attraction clearly visible, as seen on the underwater cameras used there to monitor salmon feeding and growth.

It is known that the spectral sensitivities of animal eye retinas can be very close. They are closer between a species of differing maturity than between differing species. These sensitivities are normally drawn as a curve, indicating the

beginning of a particular wavelength of light sensitivity, rising to a maximum and falling again to a minimum. These curves, found by new microspectrophotometry techniques, display the bandwidth within which an animal can see a particular source of light of a particular wavelength or frequency. Where large numbers of overlapping curves occur (and they often do in animal biology) only the peak wavelengths (inducing behavioral responses like feeding) are targeted by the laser. Lasers themselves have very narrow bandwidths, usually plus or minus 10 nanometers of a peak emission. This helps greatly in their ability to target specific species.

Fish normally living near the ocean surface are exposed to most of the light radiation that animals on the land surface experience and therefore biological principles have enabled them to see the infrared to ultraviolet spectrum. In the ocean, the ambient light levels along with the spectral bandwidth narrows with increasing depth. Animals at these depths have developed a greater sensitivity to light, compensating for the reduced light levels as well as spectral bandwidth fine tuning to the only spectrums of light available down there. A unique relationship between the species spectral bandwidth and sensitivity to light as a function of depth has developed here.

In fact there are, utilising the present invention, two forms of selecting/distracting fish species and/or other aquatic species. The first is targeting the fish species and/or other aquatic species drawing them specifically into a catch region, and second is targeting of fish species and/or other aquatic species and drawing them away from and/or distracting and/or repelling them from the catch region.

An initial prototype was purchased in the form of two laser pens, one a class 3a, 532nm green laser light and a class 1a, 632nM red laser light pen. These were taken to various aquariums in order to determine the effects of this thereof on cod, codling, sea bass, whiting, gray mullet fry, tropical and other aquaria species. In another arrangement an initial prototype was constructed somewhat as shown in Figure 7 from an aluminium tube 200mm in diameter 1200mm long and with a wall thickness of 10mm. At the rounded head end borosilicate glass windows were secured to allow the passage of a single class 3b, 532nm green laser light beam from the center portion and four twenty-watt (eighty watts total) halogen filament based background lights to escape. The device was provided with control electronics and a depth activated pressure switch, positioned at the rear of the device, to enable the system. A black and white camera was also fitted for recording purposes. The device was then towed at the rear of a trawler vessel.

Results for the laser pens were as follows: -

AQUARIA SPECIES	GREEN LASER ATTRACTING	GREEN LASER DISTRACTING	RED LASER ATTRACTING	RELATIVE INTEREST
COD	NO	NO	NO	NONE
CODLING	YES	NO	NO	GOOD
WHITING	YES	NO	YES	EXCELLENT
SEA BASS	NO	YES	NO	FAIR
MULLET	YES (Fry only)	NO	YES (Fry only)	GOOD
TROPICAL	YES	NO	YES	EXCELLENT
HADDOCK*	NO	YES	NOT TESTED	GOOD

(*) Haddock tested in zero background light conditions.

The table indicates that it is possible to separate adult cod from juvenile codling consistently using a green 532nm laser and background light (from aquarium tank source). If whiting are present these too can be separated from both cod and codling with the addition of a red 632-nm laser. The haddock if also present could be distracted away from the catch by significantly and/or cyclically reducing the background light source levels.

It is anticipated that especially the Cod, Bass and Haddock species react positively to blue laser light owing to their shorter wavelength spectral sensitivities. Pelagic tuna and other commercially valuable species have predicted response behavior that again can be derived from the above basic conditions. In addition to the swim depth characteristic (i) given on page 3. The sunlit or euphotic or epipelagic zone that extends down to about 200 meters of the ocean contains ninety percent of the world ocean life. Sunlight is gradually filtered of its colour components in reducing wavelength order, with increasing ocean depth, before complete absorption and scattering removes all sunlight in the twilight or disphotic or mesopelagic zone between 200 and 1000 meters.

As a function of this gradual absorption surface fish above 30 meters have evolved to keep there red colour visual (opsin) pigments as well as greens and blues. Below this depth at about 100 meters fish have lost most of their red visual pigments and can see mainly greens and blues. Below this depth and into the twilight and midnight or aphotic or bathypelagic zones fish vision has specialised to accommodate the narrower spectrum of green/blues only, especially so because of the bioluminescent emissions centering on green/blue @ about 470nm are available down there.

Of course there exist exceptions even to this rule, such as the Black Sea Dragon deep-sea fish that uses a near infrared light @ 720nM to illuminate its prey> Aware of the fact that its prey is unable to see it! There is even a specialised very deep sea (benthic) prawn that utilises a 'third infrared eye' in order to locate the heat from, and therefore food from, seabed vents (black smokers). Infrared spectrum lasers would be needed for this and similar sighted species.

It thus appears that attraction and repulsion is directly linked to a photochemical stimulation of aquatic species feeding responses in the aquatic species brain. Many species of fish actually use photochemical (symbiotic bioluminescent bacteria generating light of various wavelengths) in order to lure prey.

The inventors have also found that air contained within a towed laser-type device act like a swim bladder of a large predatory fish/mammal. The effect is to scare away some target aquatic species, e.g. fish species, since such a fish possesses a dorsal sensor that helps avoid predators. It is thus most desirable when utilising a laser-type device that this specific gravity is, or approaches; one i.e. the swim bladder principle is negated. Results from the tube device were interesting. The waters that were being tested at that time of year contained horse mackerel, cod and whiting. Responses from the trawlers on-board tracking equipment that represented fish as green dots (Owing to swim bladder signatures) showed a straight line of irregularly spaced dots. Indicating that fish (probably whiting) were in fact following the path of the laser beam although at a consistent distance (estimated at around 4 meters ahead of the tube). It was again a likely result of excessive air being present in the tube at the time that kept the fish at this distance from it. The light emitted by the laser contained within the tube produced a very distinct beam pattern that weakened in magnitude with increasing distance. Approximate loss of useful beam strength occurred at about eight meters based upon a 100 milliwatt output into lightly turgid water with an apparently very low beam divergence (Approximately 1 milliradian, 1 millimeter aperture), that was attributed to continuous absorption.

Further information on aquarium lighting spectra indicate that any background lights should in fact have been high intensity discharge (HID) lights with colour temperatures ranging from 3,500 to 15,000 degrees Kelvin matching aquarium conditions and associated tests.

A sonar absorbent material coating the laser transportation device is also advised. A further benefit of solid and/or solid foam filling the device is that it is incompressible at the high pressures that exist at great depths (preventing puncture) and naturally acquiring the robust properties that are essential for normal trawler operations.

Accordingly therefore to the first aspect of the invention there is provided laser light aquatic species attractant and/or distractant device which comprises a laser light of a predetermined wavelength, characterised in that the species is pre-selected for catching and in that the wavelength of the laser light is selected to catch and/or distract the species concerned. The laser light given above may comprise of at least two laser lights of different wavelengths for example red and green. Alternatively there may be three or more wavelengths of which one is blue e.g. a wavelength between 10 nanometers and 2 millimeters and most preferably between 180 and 1064 nanometers, in any combination. Preferably the device is filled with a resin/foam to give a value to the assembly at least approaches one. It is preferred that the one device is tethered to a mother ship preferably by means of an electrically conductive cable, but of course batteries may be used either within the ship or indeed within the device as necessary. Another preference is a device attached to the base of the mother ship on a gimbaled system providing a relatively stationary beam in relation to the motion of the mother ship.

In a preferred embodiment the device comprises an electric motor driving an angled mirror that deflects the rays of at least one laser of a predetermined wavelength via another reflective surface to the exterior to form *inter alia* a visible and/or humanly invisible (i.e. UV) continuous or discontinuous ring about the mouth of the trawler net and/or directed away from and /or into the mouth of the net as desired. The device may further comprise a self-levelling device and/or background lights. The device of the present invention may also comprise a differential pressure switch that switches from one laser and/or to another as the device falls through the various zones. In another embodiment, the laser or lasers is/are mounted along with a camera on an X and Y axis driven platform contained within an optically clear hemispherical head unit on the device. Positional information for the mobile platform being derived from an echolocation device (sonar) mounted on the transportation device or via an electrically conductive tether to the trawler itself.

Other typical species that are to be found, corresponding peak retinal spectral response values and recommended laser selections table: -

Aquatic Species (Family – Latin)	Peak Retinal Pigment Wavelength (nm)	Recommended Laser Spectrum (nm)	Normal Swim Depth (m)
Majority Shallow	502-512	635-470 (*)	0-200
Majority Mid-sea	490-502	532-470	200-800
Majority Deep-sea	474-490	520-470	800-3000
Majority Juvenile	512-560	635-532	0-200

Salmonidae (**)			
Cisco	509-510	360-405-420-510	50
Sockeye Salmon	503 and 527	360-405-420-500-530	0-250
Pink Salmon	503 and 527	360-405-420-500-530	0-250

Scombridae (***)			
Pacific Mackerel	495 and 498	495	0-400
Yellow Fin Tuna	484.1	485	0-250
Horse Mackerel	498	500	600

Mid-water Shrimp	495	500	1000
Whiting	500	500	10-200
Turbot	499 and 517	500 and 520	20-70
Common Sole	501	500	0-150
Alaska Pollack	498	500	200
European Seabass	502 and 534	520	10
Haddock	494	495	10-450
European Anchovy	508	510	0-400
Flounder	507	505	1-100

(These are only some of the fish species currently living in the world ocean).

(*) Allowing for Benthic (bottom feeding) shallow water species.

(**) Salmonidae have multiple pigments including UV sensitive from recent data.

(***) Scombridae have only a single pigment therefore a single laser will suffice.

Whiting for example can see (or react to) a red light laser probably as a function of laser brightness and/or an extended retinal peak bandwidth. It should also be noted that Lasers have also got a spectral bandwidth although narrow as part of their intrinsic properties. In some cases it may be necessary to included central or side bandwidth filters to narrow or specialise their frequencies further. In some other cases exact frequency lasers are currently unavailable until future developments in tunable types and/or dedicated frequency types become available. Similarly the method of laser deployment into its corresponding fishing environment will affect the outcome.

Obviously the history of a particular species tends to derive its outcome and none more so than fish, that have had a very long period of time (and a very large area of water)! within which to specialise to their particular environments.

Some of the above species have monochromatic (single colour vision spectra, owing to single rhodopsin pigment), such as the *sergestes similis* or mid-water shrimp. Others have dichromatic vision such as the teleost salmon and herring and others have trichromatic and tetrachromatic vision allowing them to see in all humanly visible colours and infrared or ultraviolet. Others like the dolphin (cetaceans) although a mammal, do not have the ability to even see the colour blue, which is unusual owing to its proximity to the surface waters. The term 'aquatic', also includes *mollusca cephalopoda, chordata pisces*, cetaceans and *arthropodum crustacea*.

In a particularly preferred feature the modulation frequency is altered according to water absorption and other characteristics. The modulation may define a mark to space ratio introduced into the immersion characteristics enabling either a solid, segmented or dotted line, light cone to be established in the sea for example.

According to a further aspect of the invention there is provided a means for pre-selecting an aquatic species such a salmon for grading purposes prior to culling.

According to a further aspect of the invention provides a means for pre-selecting an aquatic species such as cetaceans to prevent their capture during trawling operations.

According to a further aspect of the invention provides laser light modulation to protect valuable by-catch species such as cetaceans from overexposure to laser radiation.

According to a further aspect of the invention there provides a remotely operable vehicle (ROV) system, whereby the operator has an automatically targeting sonar system, to aid in the selection of laser type and therefore species type capture.

According to a further aspect of the invention provides microspectrophotometry data to aid in the selection of laser types for specific species capture.

According to a still further aspect of the invention provides a relationship between the species spectral bandwidth and sensitivity to light as a function of depth.

The invention will now be described, by way of illustration only, with reference to the drawings wherein: -

Figure 1 is a schematic view of a first prior art fish-hook,

Figure 2 is a schematic second prior art section of a trawler net,

Figure 3 shows a schematic view of third prior art laser diode assembly,

Figure 4 shows a schematic view of trawler and trawler net in the process of fishing,

Figure 5 shows a schematic view of a trawler and trawler net and submerged laser light trawler attachment in the process of fishing,

Figure 5a shows a schematic rear view of a trawler and submerged laser light attachment,

Figure 6 shows a schematic view of a trawler and a trawler net submerged laser light net attachment in the process of fishing,

Figure 7 shows a schematic side elevation view of a trawler/trawler net attachment in a preferred embodiment of a laser light lure in accordance with the present invention,

Figure 8 shows a schematic front elevation of a trawler net/net attachment in a preferred embodiment of the laser light according to the present invention,

Figure 9 shows a schematic rear elevation view of a trawler/trawler net attachment in a preferred embodiment of the laser light lure in accordance with the present invention,

Figure 10 shows a schematic side elevation of a trawler/trawler net attachment as in Figure 7 but with additions, and

Figure 11 shows a side view in a section of one half of another device in accordance with the present invention.

Figure 12 indicates the relationship between species spectral bandwidth and sensitivity to light as a function of depth.

With reference particularly to Figure 5 there is provided a trawler (7) provided towards its rear with ropes (8) holding a trawl net (9) in accordance with practices well known in the art. Fish (10) are shown diagrammatically, as is the sea surface (11). A tether (14) is to be found securing a device in accordance with the present invention (24) to the trawler for a said device (24) extending a beam (13) towards the mouth of the trawl net (9). Alternatively as shown in Figure (6) the device according to the invention (24) is provided with lugs (15) which are secured to the neck of the trawl net (9) to attract fish therein too. Alternatively as shown in Figure 5a the laser device (24) is shown secured to the trawler (7) by means of tethers (14) which may be electrically conductive if desired below the surface of the sea (11). With reference to Figure 7 the laser light lure (24) comprises two parts. The front part machined and/or die-cast metal alloy and/or molded plastic casing (32) and a rear casing machined and/or die-cast metals alloy and/or molded plastic casing (31). The front casing (32) has a centrally threaded core (33) into which the pre-selected wavelength laser module (22) is fitted and secured with small threaded fastener (26). The purpose of the small threaded fasteners is to easily replace the laser module if changing to another pre-selected wavelength laser or replacement after laser failure during normal use and to maintain proper alignment in normal use. The secondary focusing lens (12) is fitted centrally along the same axis as the laser module (22) and is also secured with small threaded fastener (26). The purpose of these small threaded fasteners is to maintain the proper alignment in normal use and set the focal distance of the laser module (22) with respect to the secondary focusing lens (12). Between the small threaded fasteners of the second focusing lens (22) is a small compressible 'O' ring (25). The purpose of the 'O' ring is to prevent water ingress into the laser module (22). In addition to the front casing (32) are four large eye hooks or lugs (15) to enable secure fastening to either the trawler boat (7) and/or the trawler net (9). Between the front casing (32) and the rear casing (31) is a large compressible 'O' ring (23). The purpose of this 'O' ring is to prevent water ingress between the front casing (31) and the rear casing (32) whilst maintaining access to the inside of the laser light lure (24) where the replaceable or preferably rechargeable battery (17) and the immersion control electronics (21) reside. The large internally threaded ring fastener (27) aids in compressing the large 'O' ring (23) whilst the front casing (32) and the rear casing (31) are being screwed together. The large ring fastener (27) is also a machined and/or die cast metal alloy and/or molded plastic component.

On the same axis as the laser module (22) at the rear of the casing (31) is a water depth pressure sensor (19) that has a variable depth setting by a potentiometer (not shown). The water depth sensor (19) is secured with small threaded fastener (26). Again a small 'O' ring (25) Is placed between the threaded fasteners to

maintain water ingress protection. Water depth pressure sensor (19) is connected by electrical means (30) to the immersion control circuitry (21) and is a safety feature that may be omitted or bypassed as required. Above and below the water depth sensor (19) are two electrical contacts (18) mounted on an electrically insulating surface (28) on the rear casing (31) metal surface. On the rear casing (31) the two electrical contacts (18) are connected by insulated electrical means (30) to the immersion control circuitry (21) through the apertures (34) in the rear casing (31). A waterproof sealant (25) fills the remaining part of two apertures (34), in order to provide protection from water ingress. The electrical contacts (18) turn on the laser module once it is immersed in water and provide all or part of the overall safety feature of the device. Owing to the hazardous nature of laser radiation and the requirements of safety to the operator of such equipment, these features may be incorporated into the laser light lure as desired. Within the cavity (16) of the rear casing (31) are found the immersion control electronics (21), which are connected by electrical means to the replaceable rechargeable battery (17) that are housed in the waterproof section. Alternatively the rechargeable batteries (17) can be replaced by means of an electrically conductive cable (14) which tethers the device to the boat and through which power may be supplied to the device if desired.

With reference to Figure 10 all the numbered elements are the same as in Figure 7 with the exception of those noted below. A white light bulb (35) that is of a higher density low wattage, type is one of four spaced equidistantly about the device of figure 10. A clear glass water ingress protected element (36) is disposed over the bulb (35). A reflective surface (37) provides a good surface to emit as much of the bulbs radiation forward as possible. The bulb (35) is in electrical contact with the electrical supply. The arrangement of figure 10 enables certain fish stocks to be caught and/or repelled efficaciously.

With reference to Figure 11 there is provided a casing (53) that is of a generally circular cross-section. The embodiment of Figure 11 is shown as one half of the whole for reasons of clarity. The other is identical to that described and/or the arrangement can terminate in a device that is shown as in Figure 11 or via remotely operable vehicle design (not shown).

With reference again to Figure 11 casing (53) is filled with a resin and/or rigid foam as in (54) and incorporates a differential pressure switch (not shown). Towards the upper end of the casing (53) is a glass or optically clear plastic dome (40) which is linked to the casing (53) by a means of 'O' rings (41) and secured in a watertight fashion (not shown). The 'O' rings (41) act to prevent water ingress. Spaced parallel to the axis of the casing (53) but slightly inboard thereof, are at

least two, and preferably four high intensity discharge bulbs (42) disposed in a spaced array (43) with reflector (64) in the usual fashion. The high intensity bulbs (42) are actuated by means of electrical power either from the rechargeable batteries or from an electrically conductive tether (14) with electrical power from the trawler or other ship towing the device. The body of the casing (53) also comprises a speed controlled electrical motor (44) along with three lasers (two of which are numbered herein, 45 and 46) which are disposed equidistantly about a motor spindle (48). With one, two or all lasers (45 and 46) switched on the laser beam/beams (66) hits right angle mirror pairs (47) while the motor (44) is running and rotating. An ellipsoidal mirror (49), which has the effect of displacing the laser lights to a ring without unduly scattering light. The device is retained in a desired mode e.g. horizontal by means of self-leveling devices (51) disposed about a casing (53). The self-leveling device (51) is driven by a pump (52). The mirror (49) is spring-loaded (50) to increase the diameter of the projected laser light cone with an increase in speed of the motor (44) and hence of the motor spindle (48). The mirror (49) has a calculated weight (56) placed on the underside and opposite end of the spring (50), to aid its motion to horizontal (from almost vertical) with increasing motor spindle (48) speed. The calculated weight (56) is designed so as not to introduce any excessive eccentricity to the motor spindle (48) during rotation and is approximately equal to a greater or lesser percentage of the spring (50) mass. The mirror (49) itself is supported by a free rotating pin type shaft (63) passing through the motor spindle shaft (48). The motor shaft spindle (48) itself is supported by bearings (60) to maintain concentricity during rotation. The replaceable laser housing (62) is held in position by dowels (57) secured to casing (53). The dowels (57) pass through a rubber shock resistant bumper ring (58) aiding mechanical protection to the lasers (45) and (46). Back-plate (61) acts to secure the motor (44) and the rear circular shock resistant rubber mat (65) into place. The laser housing (62) is again secured into place from the back-plate (61) end by means (not shown). Conductors from lasers (45) and (46) pass to the control electronics (67) and onto the batteries (not shown) by conductor (68). The pump (52) and differential pressure switch (not shown) is also connected to the control electronics (67) by electrical means (not shown).

With reference to Figure 12 there is provided a laser selection region graph, plotting light sensitivity increasing with depth, against aquatic species spectral bandwidth. The solid line curve representing shallow water species with lowest light sensitivity and widest spectral bandwidth. The intermittent line curve representing mid-water species with intermediate light sensitivity and intermediate spectral bandwidth. The dotted line curve representing deep-water species with highest light sensitivity and narrowest spectral bandwidth.

CLAIMS

1. A laser light aquatic species as herein defined attractant or distractant device which comprises a laser light of a predetermined wavelength,

   characterised in that the species is pre-selected for catching and/or distracting in that the wavelength of the laser light is selected to catch and/or distract the species concerned.

2. A laser light according to claim 1 comprising at least two laser lights of different wavelengths.

3. A laser light according to claim 2 wherein the wavelengths are such as to provide green and/or blue lasers.

4. A laser light according to claims 2 or 3 wherein the wavelengths are selected between 180 nanometers and 1064 nanometers in any number of combinations.

5. A laser light according to any preceding claim wherein the device is filled with a resin and/or rigid foam to give a value in water approaching unity.

6. A laser light device according to any preceding claim wherein the device is tethered to a ship or trawler.

7. A laser light device according to claim 6 wherein the device is tethered by means of an electrically conductive cable.

8. A laser light device according to any preceding claim wherein the device comprises an electric motor driving an angled mirror which deflects the rays of at least one laser of a predetermined wavelength via another reflective surface to the exterior to form *inter alia* a visible and or invisible ring about the mouth of a trawler net and/or directed away from the mouth of the net.

9. A laser light device according to any preceding claim further comprising a self-leveling device and a background light.

10. A laser light device according to any preceding claim wherein the device is subject to a differential pressure switch which switches from one laser and/or to another at a predetermined depth.

11. A laser light according to claim 1or 2 wherein the modulation frequency is altered by water absorption characteristics.

12. A laser light according to claim 11 wherein the modulation defines a mark/space ratio introduced into the immersion characteristic enabling either a solid, segmented or dotted lines light cone to be established in the aqueous environment.

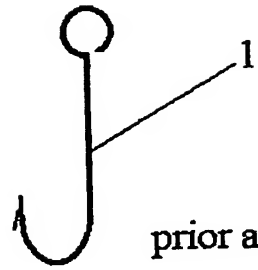
13. A method for catching and/or distracting a pre-selected aquatic species as herein defined which comprises tethering a large net behind a trawler or other ship to catch the species, characterised in that the trawler or other ship comprises a tethered sub-sea laser device giving off a laser light of a pre-determined wavelength directed at the mouth of the trawl net.

14. A method according to claim 13 characterised in that the trawler or ship comprises means for commanding an ROV.

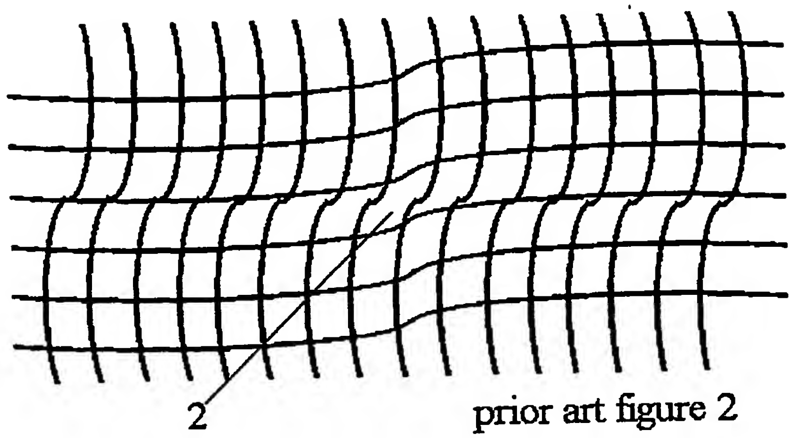
15. A method according to claim 13 characterised in that the wavelength of light is between 180 nanometers and 1064 nanometers as a function of the swim depth of the target species.

16. A method according to claim 11-13 wherein the device is located adjacent the trawler or ship or at the neck of the trawler net or at aquaculture repository.

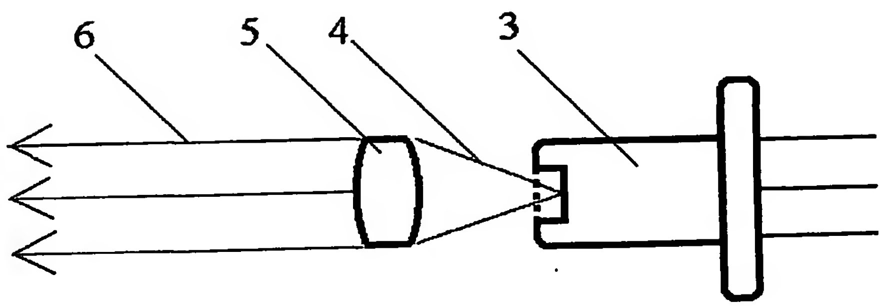
17. A method according to any of claims 11-14 wherein the device comprises a differential pressure sensor which switches on a set of lasers of different wavelengths according to the depth of water recorded on the differential pressure sensor.



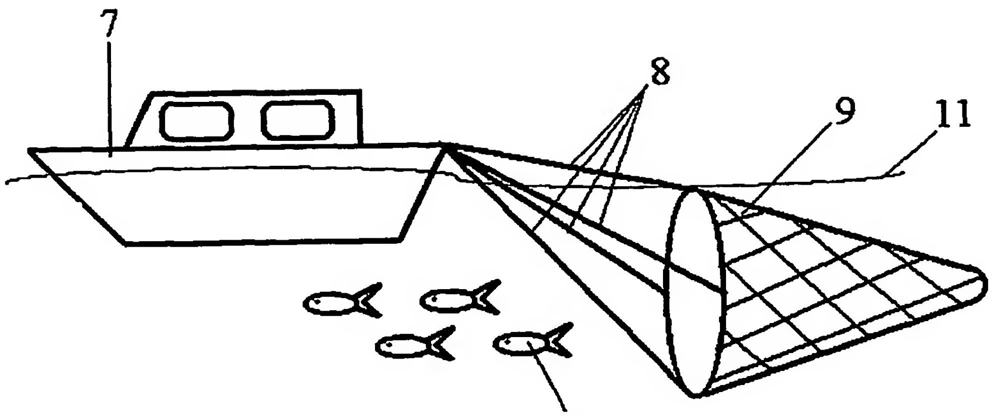
prior art figure 1



prior art figure 2



prior art figure 3



prior art figure 4.

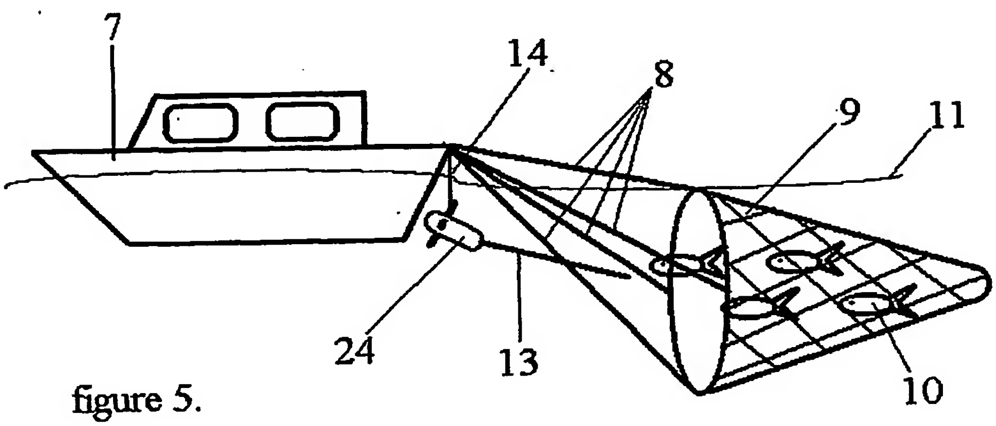


figure 5.

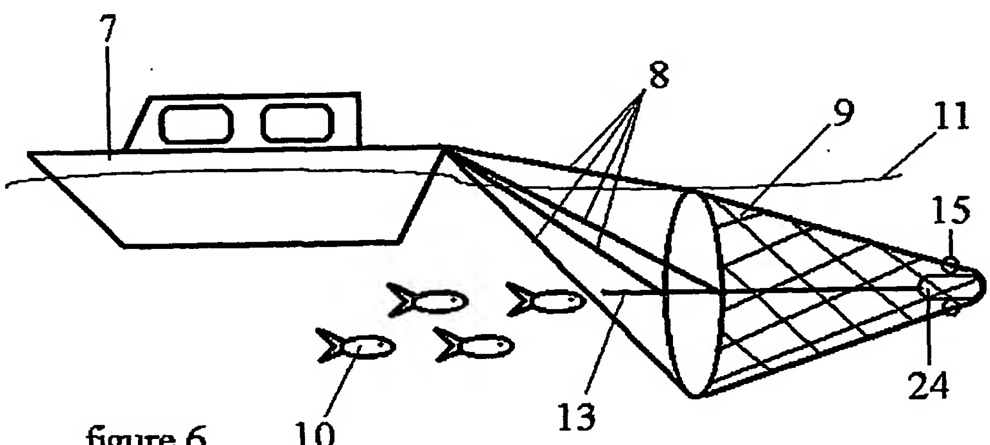


figure 6.

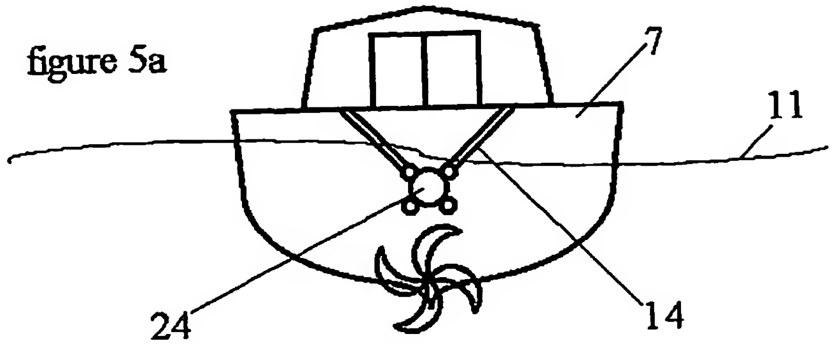


figure 5a

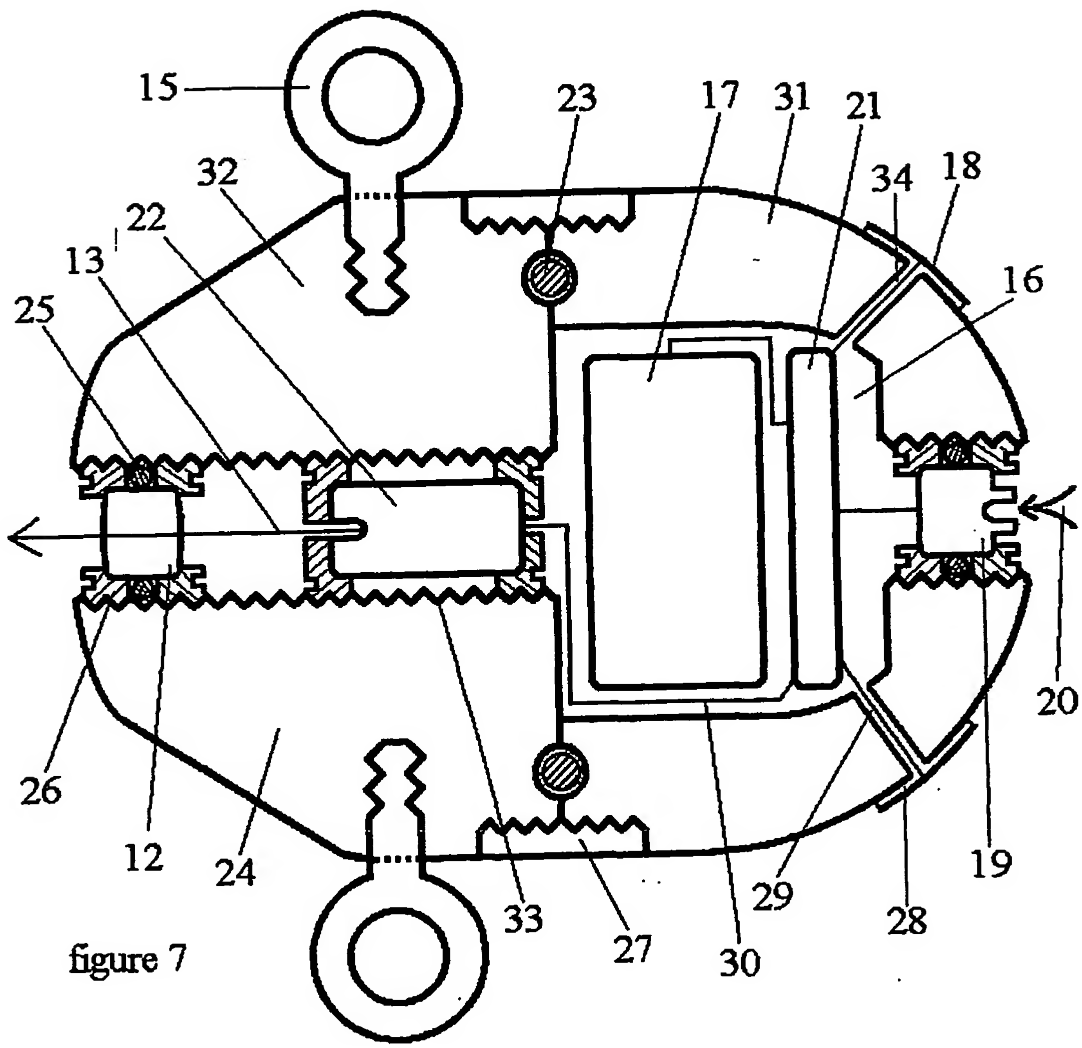


figure 7

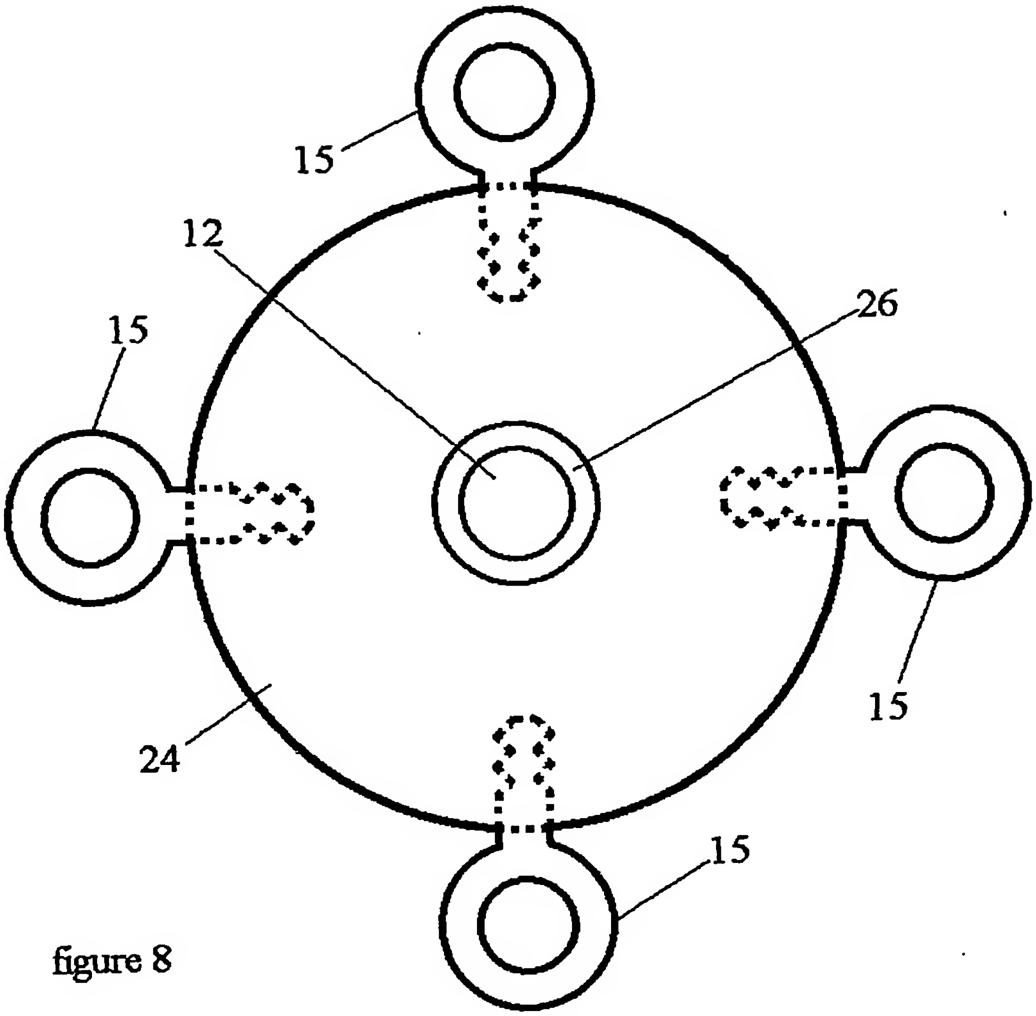


figure 8

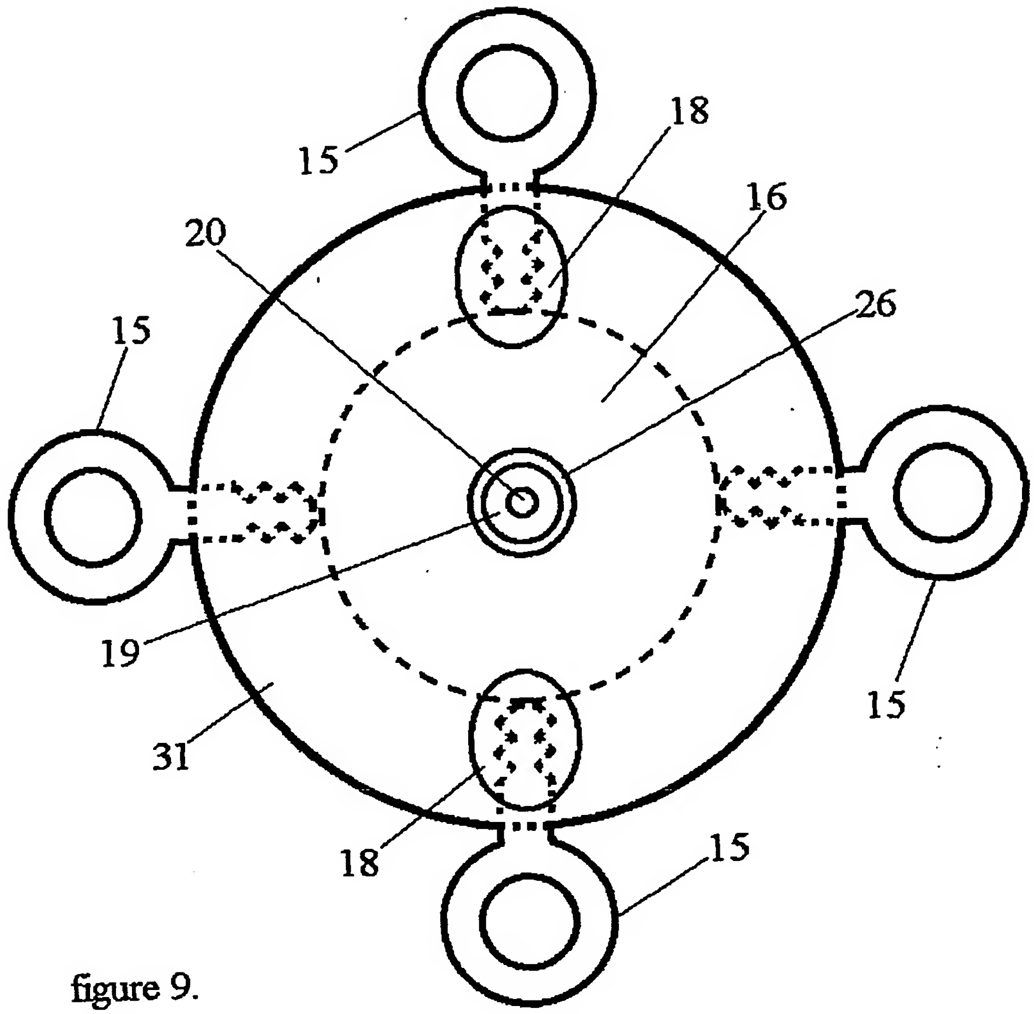


figure 9.

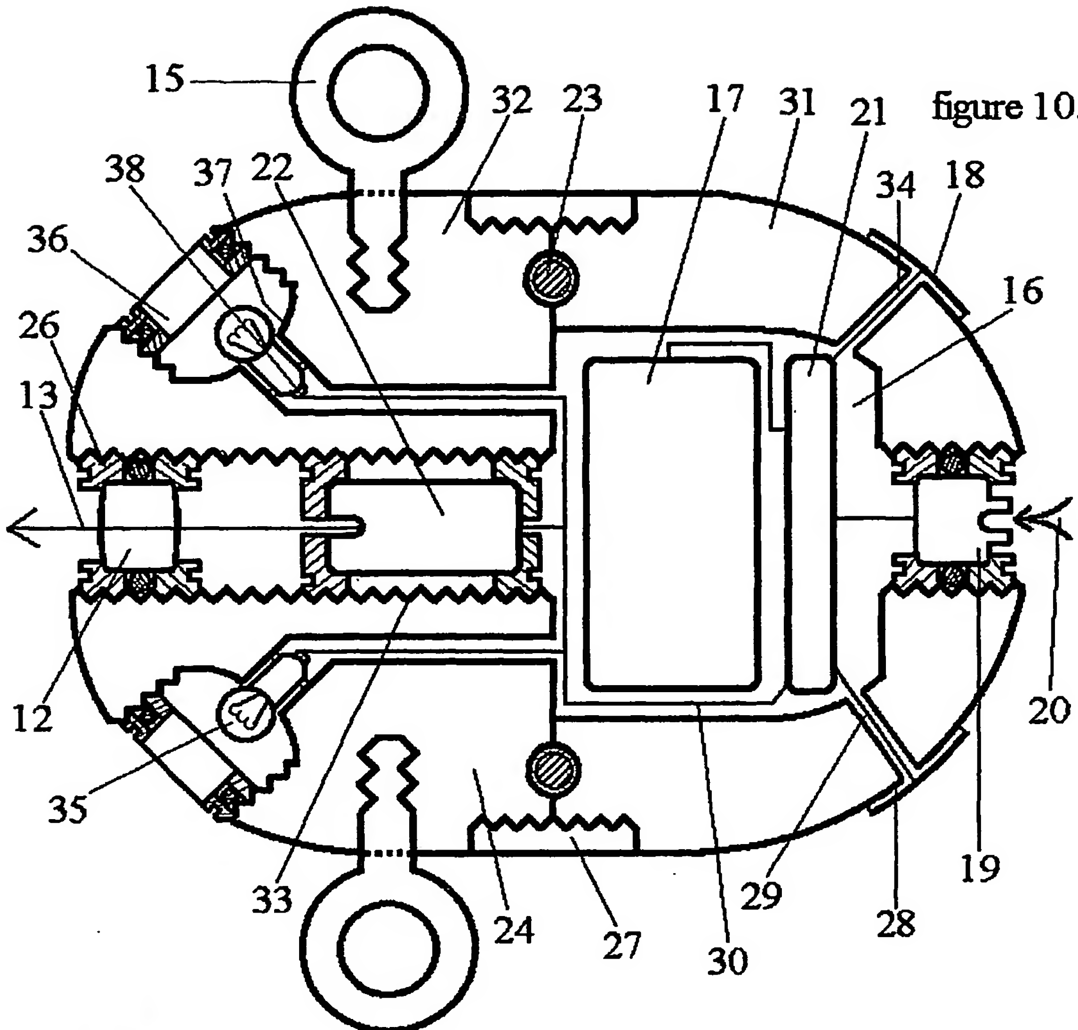


figure 10.

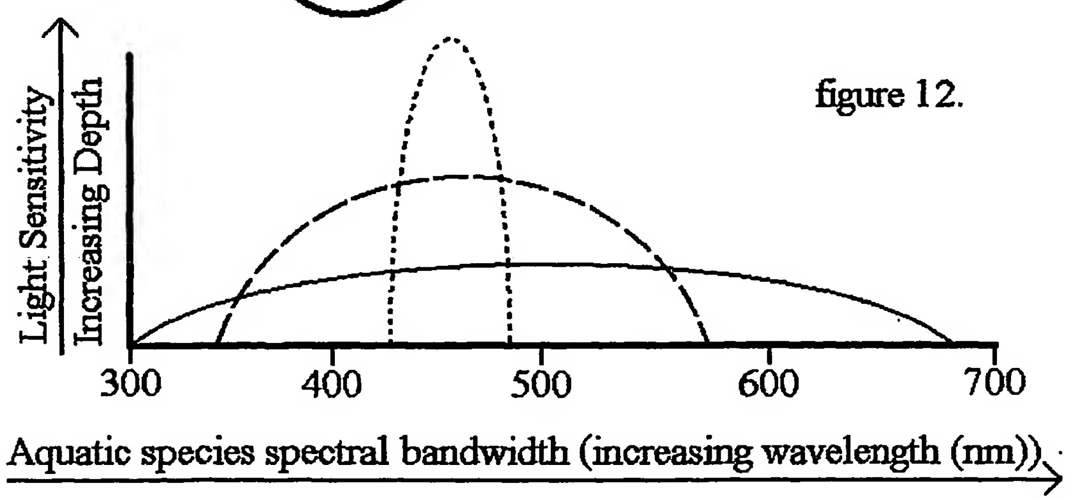


figure 12.

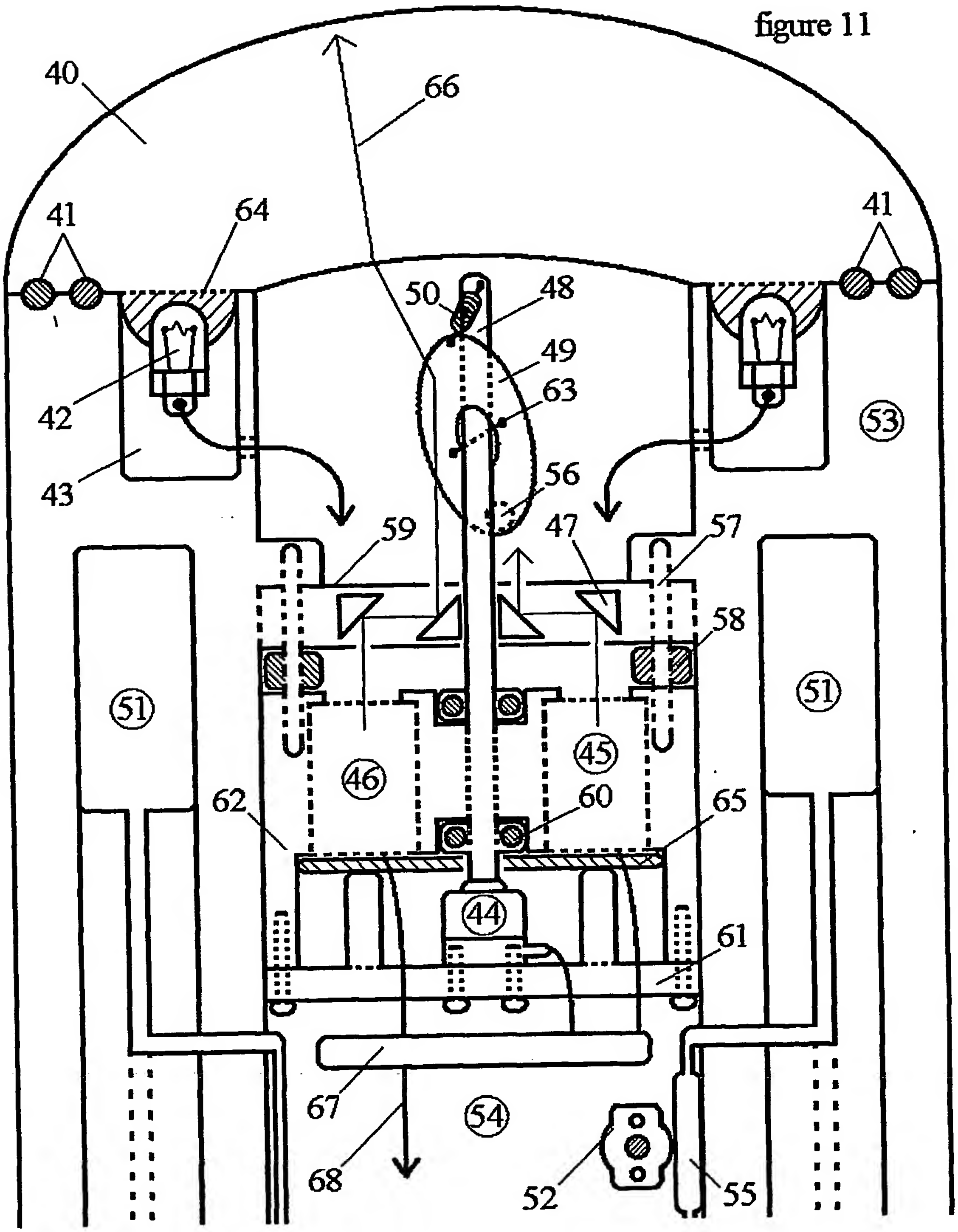


figure 11
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INTERNATIONAL SEARCH REPORT

PCT/GB 02/01991

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A01K75/02 A01K85/01 A01K79/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A01K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 815 815 A (MORI KEI) 28 March 1989 (1989-03-28) cited in the application	1
A	column 5, line 37 -column 6, line 27	2-4
Y		13,16
A	GB 211 289 A (WILLIAM ERNEST SHUTTLEWORTH;HOLLINGSWORTH JOHN) 21 February 1924 (1924-02-21)	6,7
Y	page 1, line 16 - line 23 page 1, line 57 - line 68; figure 1	13,16

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 July 2002	17/07/2002
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Verdoodt, S

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 00 04769 A (MCGUIGAN PHILIP P ;FLORES ROBERT V (US)) 3 February 2000 (2000-02-03) cited in the application page 3, paragraph 2 page 4, paragraph 3 page 5, paragraph 4 ---	1,3,4
A	US 5 758 450 A (YOUNG BRUCE A) 2 June 1998 (1998-06-02) cited in the application column 4, line 11 -column 5, line 56 ---	1,4,8,10
A	US 4 501 084 A (MORI KEI) 26 February 1985 (1985-02-26) cited in the application the whole document ---	1

INTERNATIONAL SEARCH REPORT

PCT/GB 02/01991

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 4815815	A	28-03-1989	JP	1169710	C	17-10-1983
			JP	56072637	A	16-06-1981
			JP	58000292	B	06-01-1983
			JP	1180056	C	30-11-1983
			JP	56075035	A	20-06-1981
			JP	57050452	B	27-10-1982
GB 211289	A	21-02-1924	NONE			
WO 0004769	A	03-02-2000	AU	4871399	A	14-02-2000
			WO	0004769	A2	03-02-2000
US 5758450	A	02-06-1998	NONE			
US 4501084	A	26-02-1985	JP	1469871	C	14-12-1988
			JP	59028427	A	15-02-1984
			JP	63018445	B	19-04-1988
			AU	554329	B2	14-08-1986
			AU	1750583	A	16-02-1984
			CA	1204284	A1	13-05-1986
			KR	8701613	B1	17-09-1987
			NZ	205204	A	11-06-1986